



# Drill Kart

Written By: Gever Tulley

## TOOLS:

- Drill and drill bits (1)
- Driver bits (1)  
*for screws*
- Forstner bits, 3/8" and 1" (1)
- High-speed rotary tool (Dremel) with cutting wheel (1)
- Metal file or grinder (1)
- Saw(s) (1)  
*for crosscutting 2x4s and cutting plywood*
- Socket set and ratchet, or various wrenches (1)
- Welder (optional) (1)

## PARTS:

- 2x4 lumber, about 40' (1)  
*for the frame. Instead, you could use steel box beam and a welder.*
- Plywood (1)  
*for the deck*
- Wood screws or deck screws (1 box)
- Wood screws (8-12)
- 16" or 20" bike rear wheels with gear hubs (2)  
*like from kids' bikes or BMX bikes.*  
*They're cheaper and give more torque than full-sized bike wheels.*
- Caster (1)
- Steel brackets (4)  
*You can buy mending plates at the hardware store; we made our own by drilling 2" holes in flat steel bar.*
- Bolts, 3/8", with matching nuts and washers (4)  
*for the dropout brackets*

- Bolts, 3/8", with matching nuts and washers (4)  
for the caster
- Machine screws, with nuts and washers (12)
- Machine screws with nylon insert nuts or pairs of jam nuts (6)
- Cordless drills (2)  
preferably 36V. We used 2 Bosch  
Litheon Brute 36V drills.
- Bike rear wheel hubs (2)  
Freewheel hubs are easily salvaged  
from damaged wheels (ask a local  
bikeshop). To get a nicer alignment of  
the drills on the kart, you can substitute  
one fixed ("fixie") hub, or weld one  
freewheel to act like a fixie.
- Bike drive chains (2)
- Seat (1)  
We got ours from an old office chair.
- Steel pipe (3'-4')
- Optional: Nylon tie-down straps,  
plexiglass, paint (1)

## SUMMARY

**This project is a collaboration between Gever Tulley and MAKE Labs.**

Educator and MAKE author Gever Tulley helps kids build their own drill-powered go-karts at his Tinkering School in Montara, Calif., using small welded frames, bike parts, and cheap corded drills. We asked him to build a version for this issue, but we wanted it to be large and powerful enough to carry an adult driver, and we wanted to go cordless.

Our kart would need a different geometry from the original kids' karts to accommodate full-

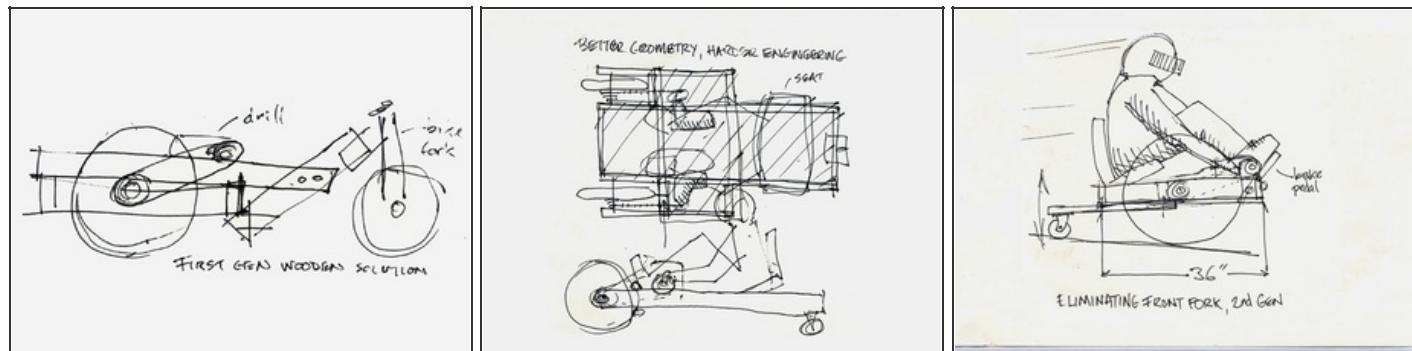
sized drivers. This meant changing the drive trains, the wheels, the seat — everything. And when Gever and his assistant Theo Gough arrived at MAKE HQ in January toting buckets of bike parts and steel box beam for welding a frame, we knew it needed another change. There's no welder here at MAKE Labs, so we decided to build our kart out of lumber, not steel.

Together we conceived and built a new Drill Kart. We had a great time working through the design problems while we surmounted each challenge (metal frame to wooden frame, eliminating the front fork, moving the center of gravity), and we think we ended up with a good balance: functional, fun to drive, and easy to build.

We decided on a 3-wheel design with a heavy-duty caster in back and two 20" bike wheels in front, powered via chain drive by two 36V cordless drills. This meant we'd need two more bike hubs chucked into the drills somehow to use as drive gears. Here's how we did it.

*Special thanks to MAKE Labs engineering interns Eric Chu, Brian Melani, Tyler Moskowitz, and Nick Raymond for building, refining, and testing the Drill Kart; to Robert Bosch Tool Corp., and to West Valley Welding in Sebastopol, Calif.*

## Step 1 — Design a frame.



- Lacking a welder, we began sketching a frame made of 2x4 lumber. For the steering, we originally thought of “Frankensteining” a recovered bicycle front fork onto our wooden frame and putting the 2 drive wheels in back. But the more we looked at it, the more it just seemed heavy and inelegant.
- So we decided to replace the front fork with a rear caster and bring the 2 paired wheels in front, like on a “tadpole” trike. But they would also be the drive wheels, and you’d steer tankstyle by accelerating one motor or the other! We all liked this idea, as it drastically raised the crazy factor of our kart.
- We originally envisioned dropping the drive wheels between wooden forks, but the open wood forks on this “box with wings” just weren’t strong enough. So we decided to box the wheels in.
- This design also leaves room to install foot brakes at the kart’s front edge. You can size your kart by test-fitting the seat and its distance to your imagined foot brakes. Once you’ve located the seat, you’ll know roughly where to mount the drills for comfortable driving, and thus how big to make your frame.

## Step 2 — Build the frame.



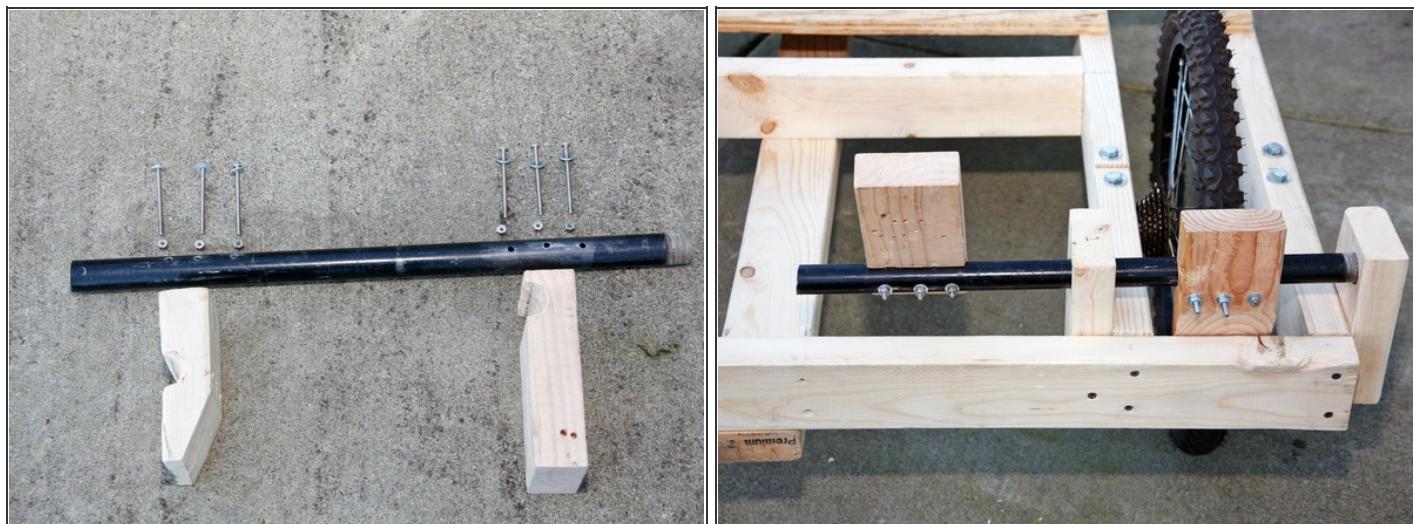
- Our frame is a big rectangle with internal braces to support the wheels and driver, plus a triangular rear extension to stiffen the long central tailpiece that holds the rear caster.
- Cut the 2x4s to length, lay them out, and mark where the wheel axles will go. Use the 3/8" Forstner bit to drill 2 dropout grooves for each axle. Screw the frame together with 2½" wood screws or deck screws.

## Step 3 — Mount the wheels and deck.



- Flip the frame upside down. Lay an axle in its dropouts, center a bracket over each dropout, mark and drill the bolt holes through the 2x4, then bolt the brackets on. You can unbolt them to remove the wheel.
- Bolt the caster to the tail of the frame. You'll probably have to add wood blocks in between to make it level.
- Finally, cut a ½" plywood deck to cover your frame, and screw it down with 1" wood screws.

## Step 4 — Make the brakes.



- We settled on simple wooden brakes that rub on the tires, with foot pedals for leverage.
- To make the brake pads and foot pedals, use the 1" Forstner bit to drill round grooves in scraps of 2x4, as shown in the first photo. Use the 3/16" machine screws to bolt a brake pad to a length of 1" steel pipe. Bolt a foot pedal at approximately the opposite angle; then mount the pipe in scrap 2x4 supports, so that the brake pad rubs the tire when the driver steps on the pedal.
- Repeat for the other wheel.

## Step 5 — Add a seat.



- From an old office chair, we got a comfy seat plus a seat back with a post that mounted easily through the frame. Your mileage may vary.

## Step 6 — Prepare the drive hubs.



- Liberate the rear hubs and axles from some old bike wheels by cutting the spokes off with a Dremel. You'll use these as the drive hubs, mounted in the drills.
- First, you need to lock the axles to the hubs. The easiest way is to jam the axle bearings mechanically. Unscrew the axle nuts and remove the ball bearings, then overtighten the axle nuts back down as hard as you can. The axle should now be frozen.
- If the axle works loose, fix it permanently by drilling and pinning the hub through the axle, using 6-32 machine screws and jam nuts (or nylon insert nuts). We used 3 screws per hub to prevent them shearing off. You could also weld the axle to the hub.

## Step 7

- The drills face opposite directions on the kart, but you have your choice of how to align the drive hubs in the drills. If you align both hubs in the same direction, you won't need to do this next modification.
- But we aligned our hubs in opposite directions, because that way the drills line up much better for sitting between them. If you do this, then one of your drive hubs must be drivable backward, so that it doesn't just "coast" against its drill. This means you'll need to freeze one freewheel entirely by welding the gears to the hub, making it a fixed hub.
- To avoid doing this "fixie" modification, you could also substitute a real fixed rear hub (popular with road racers and bike hipsters), or buy a drive sprocket like we did in the Drill Rod scooter (MAKE Volume 21, page 108) and engineer your own axle to mount it in the drill.

## Step 8



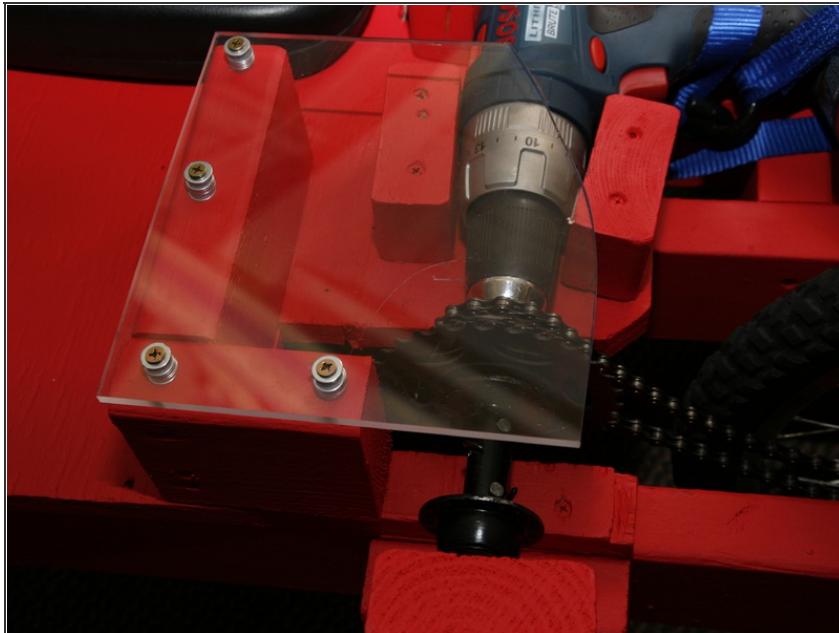
- Tip: To prevent the axle from slipping and spinning in the drill chuck, use a file or grinder to create 3 flats on the axle, at equilateral angles. Re-chuck the axle, aligning the flats with the faces of the chuck.
- Put the axles in the drill chucks and tighten them well.

## Step 9 — Mount the drills and chains.



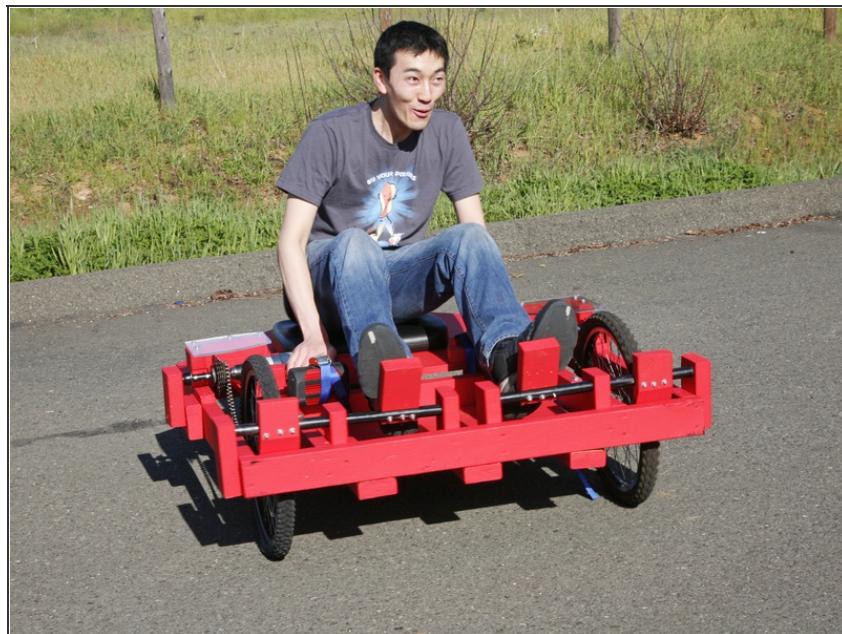
- The drills drive 2 bike chains that turn the wheels, and the gear clusters of both wheels face the same side of the cart.
- Aligning the drills is tricky — you've got to fix them securely, within reach of the driver's hands, and so that the drive hubs line up with the wheel hubs, without the chain twisting or rubbing on anything. To get the most torque, run the chain from a smaller gear on the drive hub to the largest gear on the wheel hub, like downshifting to “granny gear” on a bike.
- When you've got the alignment and chain tension right, screw down 2x4 blocks to the deck to hold each drill in place. We added straps, threaded through the deck, to tighten down the drills but still allow for easy removal. You could also box the drills in completely, if you don't want to remove them very often (just remember to leave access to the drill's battery and vent).
- To adjust the chain length, you can add or remove links and rejoin the chain with a master link or half-link. To fine-tune the tension, you could even add an idler or tensioner; this could be as simple as a smooth bolt for the chain to run over, or more complex, like the spring arm from a bike's rear derailleur.

## Step 10 — Customize (optional).



- We painted our kart a bright, MAKE-logo red, and installed cool see-through guards made from acrylic plexiglass over the drive hubs.

## Step 11 — Motor!



- Take it for a spin — and we do mean spin. The Drill Kart's crazy 2-trigger tank steering takes some getting used to, and the rear caster loves to spin out. The dual brakes should keep you out of trouble until you get the hang of it, so use them early and often.
- Have fun and be careful. You're a motorist!
- Build this kart, share your projects, and see a video of the Drill Kart in action at <http://makezine.com/go/drillkart>.
- **WARNINGS:** The drill kart is heavy, so give it a wide berth and take care not to break a leg. (On the upside, all that weight contributes to a nice low center of gravity, which helps prevent tipping.) 
- Also, take care not to  overheat your drills with too much stopping and starting or too steep a hill. Keep an eye (and a nostril) on them; if they're smoking or stinking, give 'em a rest. 

This project first appeared in [MAKE Volume 26](#), page 40.

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